Mesolithic burials – Rites, symbols and social organisation of early postglacial communities
Mesolithische Bestattungen – Riten, Symbole und soziale Organisation früher postglazialer Gemeinschaften

International Conference
Halle (Saale), Germany, 18th–21st September 2013

Edited by Judith M. Grünberg, Bernhard Gramsch, Lars Larsson, Jörg Orschiedt and Harald Meller

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A chrono-geographic look at Mesolithic burials: an initial study

Christopher Meiklejohn, Jeff Babb and Weldon Hiebert

Zusammenfassung

Eine chronologisch-geographische Sicht auf mesolithische Bestattungen: Eine erste Studie

Während der letzten zehn Jahre haben wir uns im Rahmen des Studiums der mesolithischen Bestattungen auf zwei miteinander verbundene Themen konzentriert: die Beziehung zwischen der Anzahl der Bestattungen und ihrem Alter sowie die Chronologie der mesolithischen Fundstellen mit Bestattungen. In diesem Zusammenhang wurde eine Datenbasis der metrischen Variabilität und Chronologie für den Zeitraum, eine Liste der aktuell bekannten menschlichen Knochenfunde, der Bestattungsart, der Anzahl der Individuen und der geographischen Koordinaten erstellt.

In früheren Arbeiten haben wir gezeigt, dass entgegen den Erwartungen die Anlage von mehreren Bestattungen oder von Gräberfeldern (wie auch immer definiert) nicht auf das Spätmesolithikum beschränkt sind, sondern während des gesamten Mesolithikums auftreten, möglicherweise mit jungpaläolithischen Wurzeln. Frühere Analysen betrafen in erster Linie die Anzahl der Bestattungen an einer Fundstelle und deren absolutes Alter. Der geographische Aspekt, am einfachsten definiert nach Breiten- und Längengrad, wurde nur am Rande untersucht. Wir haben gezeigt, dass weitgehend ähnliche Muster in ganz Europa auftreten, aber besonders in Nordwesteuropa. Dieser Beitrag aktualisiert frühere Arbeiten und nutzt geostatistische Ansätze zusammen mit anderen statistischen Verfahren, um erste Untersuchungen dazu vorzulegen, ob andere Muster in den Daten verborgen sind. Dies kann vielleicht helfen, herauszufinden, ob das allgemeine Muster der Bestattungen im Mesolithikum Zufall ist oder einem Schema folgt.

Summary

Over the past decade we have focused on two interrelated topics within Mesolithic burial studies, the relationship between burial number and burial date, and the chronology of Mesolithic sites with burials. Related to this has been construction of a database of metric variability and chronology for the period, an up-to-date list of known human bone finds, burial type, number of individuals, and geographic coordinates.

In previous papers we showed that, contrary to expectations, multiple burials or cemeteries (however defined) are not restricted to the Late Mesolithic but occur throughout the sequence, possibly with Upper Palaeolithic roots. Earlier analyses were primarily concerned with number of burials in a site and their absolute date. The geographic aspect, most obviously seen in latitude and longitude, was only explored in passing. We showed that patterns were largely similar for Europe as a whole and for the more circumscribed area of North-western Europe. This paper updates earlier work and uses geostatistical approaches together with other statistical procedures to provide an initial exploration of whether other patterns are hidden within the data. This may assist in answering questions such as whether the overall pattern of burial during the Mesolithic is random or patterned.

Introduction

This paper continues examination of a database developed since 2005, updating papers from the 2005 Belfast Mesolithic Congress and 2007 Brussels Chronology Conference (Meiklejohn/Babb 2009; Meiklejohn et al. 2009). We begin by describing the origin and history of the database, including its strengths and weaknesses.

Our database is, *per se*, not new. Descriptions and lists of Mesolithic burials have been of archaeological interest since the period was identified in the late 19th century (e.g. Quatrefages/Hamy 1882). However, the first clear catalogue to include Mesolithic human remains appeared as an adjunct to the 19th International Geological Congress, the *Catalogue des hommes fossiles* of Henri Vallois and Hallam Movius (1953). Focused on the Pleistocene worldwide, Mesolithic material from nine countries was included (see further below).

The 1953 volume laid the base for publication of a new edition, the *Catalogue of fossil hominids*, in three volumes between 1967 and 1975, the second dedicated to Europe (Oakley et al. 1971). However, focus was again on the Pleistocene with uneven Mesolithic coverage, partly a function of the importance of Mesolithic finds within a country. Subediting of country accounts also led to varying approaches to quality control.

At the time that the newer catalogue was being developed, one of us (CM) began compiling a catalogue of European Mesolithic sites with human remains; part of a PhD and in the aftermath of data collection in Europe in 1968–1969. This became an appendix to Meiklejohn (1974, 453–542).

Development of the database, including these three timelines, is seen in Table 1 (see Appendix), showing how the database grew. We only list sites which we identify as burials, broadly speaking, leaving out sites where finds are identified only as loose human bones (LHB). While not considering LHB finds in detail, some comment is necessary. In restricting this paper to »burials« we identify the human remains as clearly part of a culturally motivated behaviour. Production of »cemeteries«, however defined, is clearly part of this behaviour and a central focus of this paper. In contrast, we have no such »guarantee« in cases identified as LHB finds/sites. As we stated earlier (Meiklejohn et al. 2009, 640) »isolated bone finds … may reflect a number of taphonomic processes«. Unsaid is that many of these may be effectively random and without human interference. We would rather exclude this random process in our calculations than add a further unknown to the process. We are aware that one criticism will be that LHB finds may simply represent a cultural behaviour that we do not understand. For example, the human remains from Cnoc Coig in western Scotland were originally described as LHB finds (Meiklejohn/Denston 1987), while later, more focused, study showed that at least some of the finds were part of an as yet not fully understood ritual process (Meiklejohn et al. 2005). However, we also feel that such explanations may not apply to all LHB cases. We therefore stress caution before adding LHB finds to an analysis of burial, *sensu stricto*.

Before proceeding to work done since 1974 we would like to show the beginning of development of this database through the three timelines introduced above (Tab. 1, see Appendix). The table compares the database of sites used in this paper to earlier accepted databases. Sites identified in any given timeline column by »Yes« were included in the catalogue identified for this column, those identified by »X« were not. In order to clarify which sites would have been known at any given timeline we use coloured infill for sites not yet discovered and/or published at the time of publication of any of the identified databases. In addition, for the 1953 to 1974 databases we have only listed sites still considered to be Mesolithic sites for the two most recent timelines, this paper and the MESO2005 paper (Meiklejohn et al. 2009). The reason for this, elaborated further below, involves issues of quality control. Many sites discussed between 1953 and 1974 had marginal claim to Mesolithic status, in some cases simply because the possibility had been mooted. For example, Vallois and Movius (1953) list 29 sites for France whose age, even then, was seen as of »doubtful age or without palaeontological value« (ibid., 162: free translation). Several were still part of the discussion in 1971 and/or 1974.

In terms of burial sites still under consideration at present, the 1953 catalogue listed only 24 sites from eight countries as Mesolithic. A further 34 sites on the current list had been discovered but not discussed (Tab. 1, see Appendix). Eighteen years later the 1971 catalogue listed 28 burial sites as Mesolithic. A further six identified as Upper Palaeolithic are today viewed, at least in part, as Mesolithic (e.g. Aveline's Hole, Gough's Cave). By 1974 one of us (CM) used the above sources plus a year long search of the literature to identify 30 burial sites as Mesolithic and a further three as Upper Palaeolithic (Aveline's Hole, Gough's Cave, Ofnet). The first fully justified Mesolithic catalogue was still to come.

Beginnings of the current database (1979–2005)

By 1975 a small core of ~30 burial sites had been identified as of Mesolithic age. Though Meiklejohn (1974) identified over twice this number as of »possible« Mesolithic age, many were LHB sites or sites whose age remains unclear; in 1974, direct dating of human bone was still in its infancy. Oakley et al. (1971) listed no direct ^{14}C dates for Mesolithic sites. Three years later Meiklejohn (1974) listed direct dates for only six sites, three indicating a Mesolithic age (Aveline's Hole, Melby, Rhünda), the last of these an LHB find. The other three dates were post-Mesolithic (Dalkey, Kilgreany, Halling).

Though there was a base for a catalogue of Mesolithic burials it lacked consistent criteria for identifying finds as being in definite Mesolithic association. Earlier work went beyond accepting Mesolithic status simply because it had been proposed, but acceptance as Mesolithic remained on both limited and unsystematic grounds. No consistent criteria were given for verifying either Mesolithic or other association (earlier catalogues also discussed Upper Palaeolithic material). Though Oakley et al. (1971, vii-xi) used 18 categories in individual site listings, these were primarily descriptive.

Work of the time often includes material that would not be used today. For example, Petit-Maire et al. (1971) give 17 French sites with full entries, identified as likely to be Mesolithic. Today, ~59 % of sites included are now viewed as problematic: three are seen as not Mesolithic with a further seven undated and of unclear affinity. As another example, Frayer's (1978) study of Upper Palaeolithic and Mesolithic dental size identifies 41 sites as Mesolithic. At present, 17 (~41 %) would no longer be included, some older, some younger and some of unclear age. In fairness, errors of this type were not fully predictable.

From the above CM was asked in 1976 to combine his database with that of Dutch colleagues at the Universities of Utrecht and Groningen. The result (Newell et al. 1979), written in Utrecht in 1977/78, evaluated all human material referred to as Mesolithic from Europe west of the Slavic bloc, a process including examination of the archaeology, discussion with colleagues and a philosophy excluding finds not seen as unambiguously Mesolithic. Beyond the primary catalogue of demonstrated Mesolithic finds were three sub-catalogues, for finds viewed as too old, too young or of uncertain age. Exclusion of Eastern European material came from the fact that none of us worked in any Slavic language. The volume evaluated 172 sites; 75[1] had finds verified as Meso-

1 A simple count suggests that the number is 76. However, material from Vedbæk-Bøgebakken is listed under two names, one for the burials (Bøgebakken) and one for the LHB remains (Henriksholm-Bøgebakken).

lithic, an inclusion rate of ~44 %. Of these only 44 are burial sites, the rest containing LHB finds. In addition, the 1979 catalogue listed ten direct ^{14}C dates from seven sites in four countries for the 75 Mesolithic sites.

The 1979 catalogue provided a base for further work on European Mesolithic burials, and in particular on burial chronology. A further massive work appeared roughly 20 years later, the compilation of Grünberg (2000). Though a critical work in Mesolithic burial studies, it focused on burial process and burial associations rather than the two key issues here, chronology and provenance.

Since 1979, massive changes have occurred in available data on chronology and provenance. Consequently, one of us (CM), beginning in the late 1980s, created a computerised file of Mesolithic sites with human skeletal material, with the 1979 catalogue as a base, focused on the growing number of ^{14}C dates, associated stable isotope information, and references. New sites were added as they became known. This file was the base for the chronology paper we presented at MESO2005. The enormity of the changes was made clear by the fact that it took nine months following the conference (October 2005–June 2006) to compile the database used in the published paper (Meiklejohn et al. 2009). As seen in Table 1 the number of Mesolithic burial sites had by this time grown to 118, almost 2.7 times that identified in 1979. All had direct ^{14}C dates. In addition, a further 21 sites discussed as Mesolithic in 1979 were not included due to the lack of direct dates.

There were also five sites identified as Mesolithic in 1979 whose status had changed by 2009. Of the five, one is now seen as Upper Palaeolithic and earlier, one is directly dated to the Neolithic and younger, and three are now best seen as age unclear. A brief summary is appropriate. Reassessment of Abri Cornille (Bouches-du-Rhône, France), shows the graves in layer 6 to be Late Upper Palaeolithic rather than Mesolithic (Meiklejohn et al. 2010), largely due to new work on the Montadian that sees it as of Late Pleistocene age, parallel to the Azilian (ibid.). A second site, Rastel (Alpes-Maritimes, France), is directly dated to the Neolithic, with direct dating placing the burial in a Pre-Chasséen (Middle Neolithic) context (Le Bras-Goude et al. 2006), consistent with ceramic remains recovered at higher levels of the site. It should be treated as an intrusion. Three other sites should now be considered as undated. LHB remains from Kilham Long Barrow (England) were seen as Mesolithic by Newell et al. (1979) but more recent work (Fisher 1982; Conneller 2006) suggests that levels beneath the barrow may be mixed. Meiklejohn et al. (2011) suggest the need for a direct date. In the case of the single LHB find from Thatcham (England), dated by pollen from within the shaft of the bone, a Mesolithic date is possible but it is suggested that the pollen dates the sedimentary context rather than the bone (ibid.) and that fluorine and nitrogen screening is problematic. Again, direct dating is needed. Finally, the case of the partial calvarium from Ravnstrup, long-viewed as a core Danish Mesolithic find (Bröste/Jørgensen 1956), again involves dating the deposit rather than the skeletal material and direct dating is needed.

The 118 burial sites identified in the Belfast paper show the growth of known sites over the previous quarter century. It is sobering that in less than five years since publication of that paper the number used in this paper has grown a further 75 %, to 207, even though eight sites included in 2009 are not used here. To indicate further the increase in Mesolithic site numbers with human bones, an ongoing project dealing only with loose human bone finds currently lists 155 sites, many not overlapping with the list of sites with burials in use here.

Some commentary on the nature of the growth in site numbers is appropriate. Three elements are reasonably clear. One is the discovery of new sites as Table 1 (Appendix) makes obvious. The other two, closely related, involve, at least in part, the degree of justification used in 1979 for the three sub-catalogues, together with the explosive increase in available direct ^{14}C dates. For the last category the ten dates available in 1979 had grown to 421 when this paper was delivered at Halle, an average addition of approximately a dozen new dates a year. Each site has an average of 2.03 direct dates on human bone. The paper delivered in Halle has been used as the cutoff for inclusion in this paper. However, both new sites and new dates have appeared in the period between delivering the conference paper and submitting the published article.

As already indicated, the 1979 catalogue contained three sub-sections that could not be demonstrated to have human remains that were Mesolithic in age, those seen as too old, too young or as age unclear. In total, 110 sites were included, though some overlapped with entries in the main catalogue. As an example, by 1979 it was clear that the material from the primary Muge Valley shell midden sites in Portugal excavated between 1952 and 1967 by Roche and Veiga Ferreira was Mesolithic, but similar security was not assured for material excavated earlier and placed in the category of age unclear. The issue was finally resolved by direct ^{14}C dating (Lubell et al. 1986).

Sites placed into the secondary categories play a significant role in the initial expansion of site numbers beyond the 44 seen as secure in 1979. Their stability, in terms of maintaining their age placement as judged in 1979, is much lower than for the main catalogue. A core reason is the explosion in direct ^{14}C dates. A second is that, in general, less attention was paid to evaluating these sites than to those in the core catalogue, especially once it became clear that they were not securely Mesolithic. Thirdly, close rereading of site placement in 1979 shows inconsistency, especially in assigning sites to the categories of too young and age unclear. In 1979 nine sites were seen as Upper Palaeolithic (part II), 24 as Neolithic or younger (part IV) and 77 as age unclear (part III). Of the first, only three of nine are still demonstrably seen as Upper Palaeolithic, all involving direct ^{14}C dating. Two are viewed as Mesolithic, Ofnet (Germany) through direct dating, Los Azules (Spain) from reassessment of the archaeology, the latter involving changes in our understanding of the Azilian (see discussion in Meiklejohn 2009, 11). Azilian materials must be analysed on a case-by-case basis. For Los Azules the burial is bracketed by Preboreal dates on charcoal and there is no reason to see it as other than Holocene and Mesolithic (Straus 1985; Meiklejohn/Straus 1986). Finally, of nine sites, new analyses of four see the finds as of unclear age.

Turning to the 24 sites seen as »demonstrably younger« than the Mesolithic, only one is now known to be Mesolithic, Tilbury I in England (Schulting 2013). A further twelve are still viewed as younger than Mesolithic, eight resulting from direct ^{14}C dating (two examined in 1979 already had post-Mesolithic ^{14}C dates). However, eleven are now in the age uncertain group.

Finally, of 77 sites viewed as »age unclear« in 1979, a number are now viewed as Mesolithic. Direct ^{14}C dating is the critical factor. Thirty-five are now placed into a specific chronological period, all but one the result of direct dating, the exception based on new archaeological analysis (Havnø, Denmark; cf. Hellewell/Milner in the present volume). Of the total group, one is now seen as Upper Palaeolithic, 21 as Mesolithic, four as Neolithic, and nine as post-Neolithic. This is a major addition to those included in 1979 in the original main catalogue. The remaining 42 sites have seen no change in status, largely because of lack of further analysis.

Getting to the current database (2009–2013)

It is interesting to compare what was known, at least in theory, in 1979 compared to 2009. Of 118 sites listed in 2009, 62 were discovered in 1979 or earlier (Tab. 1, see Appendix), the other 56 discovered in 1980 or later. The »visibility« of new sites is an obvious factor. There is always a lag between site discovery and its recognition by those working in the field. This can be seen in the large increase in site number used in this paper with that available in 2006, the cut-off for adding new sites to the 2009 paper, from 118 to 207. However, as seen in Table 1, only seven were either discovered after 2009 or first identified as Mesolithic in this period. The time from discovery until first appearance in the dataset is tied to the first variable but only loosely. In the list of sites first included in 2013 but discovered before 2009, 13 were found in the 1980s and a further 13 in the 1990s.

The above discussion shows the ever present lag between discovery of new sites and their significance becoming apparent. Even the number of sites used here, with a cutoff point being the conference presentation in September, 2013, is out of date as we write this paper five months later. Both additional sites and dates are available, a process similar to that occurring in 2005 and 2006 during writing of the Belfast paper. The complexity of the earlier revision process led to the series of »chronology« papers appearing in *Mesolithic Miscellany*.

Before summarising the Belfast and Brussels results we shall briefly review the expansion of information, again stressing that the numbers are restricted to sites with burials as opposed to LHB finds. The 44 sites identified in 1979 had grown to 118 by 2009, an increase of almost 2.7 fold, while by 2013 this had grown to 207, an increase of 1.75 fold from 2009 and 4.7 fold since 1979. In 1979 twelve countries were included, over half the sites from France (12) and Denmark (11). One other country, Sweden, had more than three sites and five had one site each. By 2009 there were 21 countries, partly due to increased geographic coverage. Two had over ten sites, Denmark (20) and Germany (14), and the average was ~5.6 per country. Five had one site each. Finally, by 2013, 24 countries were represented with an average of ~nine sites per country. New countries represented were Czech Republic (one site), Estonia (three sites) and Ireland (four sites). Ten countries had ten or more sites and three had over 20, France (32), Denmark (26) and Germany (23). As already noted, this increase in site number was more than matched by the increase in available ^{14}C dates.

A final comment concerns the degree to which our current list is up to date. The single longest standing issue concerns access to data in countries not reviewed in 1979 due to lack of fluency in any Slavic language. Our knowledge of sites in Eastern Europe is still limited and real site numbers are probably higher, possibly much higher, than given here. An insight into the potential is seen in Oshibkina (2008; see also Wood et al. 2013) who identifies eight sites in Russia and Finland as »Mesolithic burial grounds« for which we currently (as of September 2013) have insufficient information to include in our dataset. The potential for change can also be seen in the dating articles that one of us has published in *Mesolithic Miscellany* since 2009 (e.g. Meiklejohn et al. 2010; 2011). Each of the seven published and projected articles have located new sites, both published and unpublished. In addition, in all but two of the five countries with articles published at the time of the Halle meeting (Portugal and Ireland) we have sites in the current database not discussed in *Mesolithic Miscellany*, three from Spain, four from France and three from Great Britain. The process of preparing these articles has aided the process of updating the database; a fact that we feel justifies the work involved. As perhaps the most obvious example, none of the four Irish sites included in the current paper were discovered in the process leading to publication of the 2009 Belfast paper though all had been discovered at the time (not all had been dated). We now turn to the basis for this paper; the results published from the 2005 Belfast Mesolithic Conference and the 2007 Brussels Mesolithic chronology meeting.

The Belfast and Brussels papers

Our published papers from Belfast and Brussels both appeared in the same year (Meiklejohn/Babb 2009; Meiklejohn et al. 2009). The Belfast paper addressed an issue raised by Erik Brinch Petersen and one of us (CM) at the 1995 »Jomon to Star Carr« meeting (Cambridge/Durham) involving cemetery chronology and the ongoing debate over the rise of »complex« societies (for a revised version see Brinch Petersen/Meiklejohn 2007).

At issue was whether a relationship existed between sites defined as cemeteries and apparent changes in social structure thought to accompany the Neolithic. Central were »attempts to link Mesolithic graves and burial practice to the development of burial behaviour in the Neolithic and post-Neolithic periods (e.g. Champion et al. 1984; Clark/Neeley 1987; Whittle 1985)« (Brinch Petersen/Meiklejohn 1995). This idea stemmed from the »default« position at the time, that cemeteries, however defined, occurred only as Late Mesolithic phenomena. In a widely quoted article Clark/Neeley (1987; see also Mithen 1994) provided a mean age for known

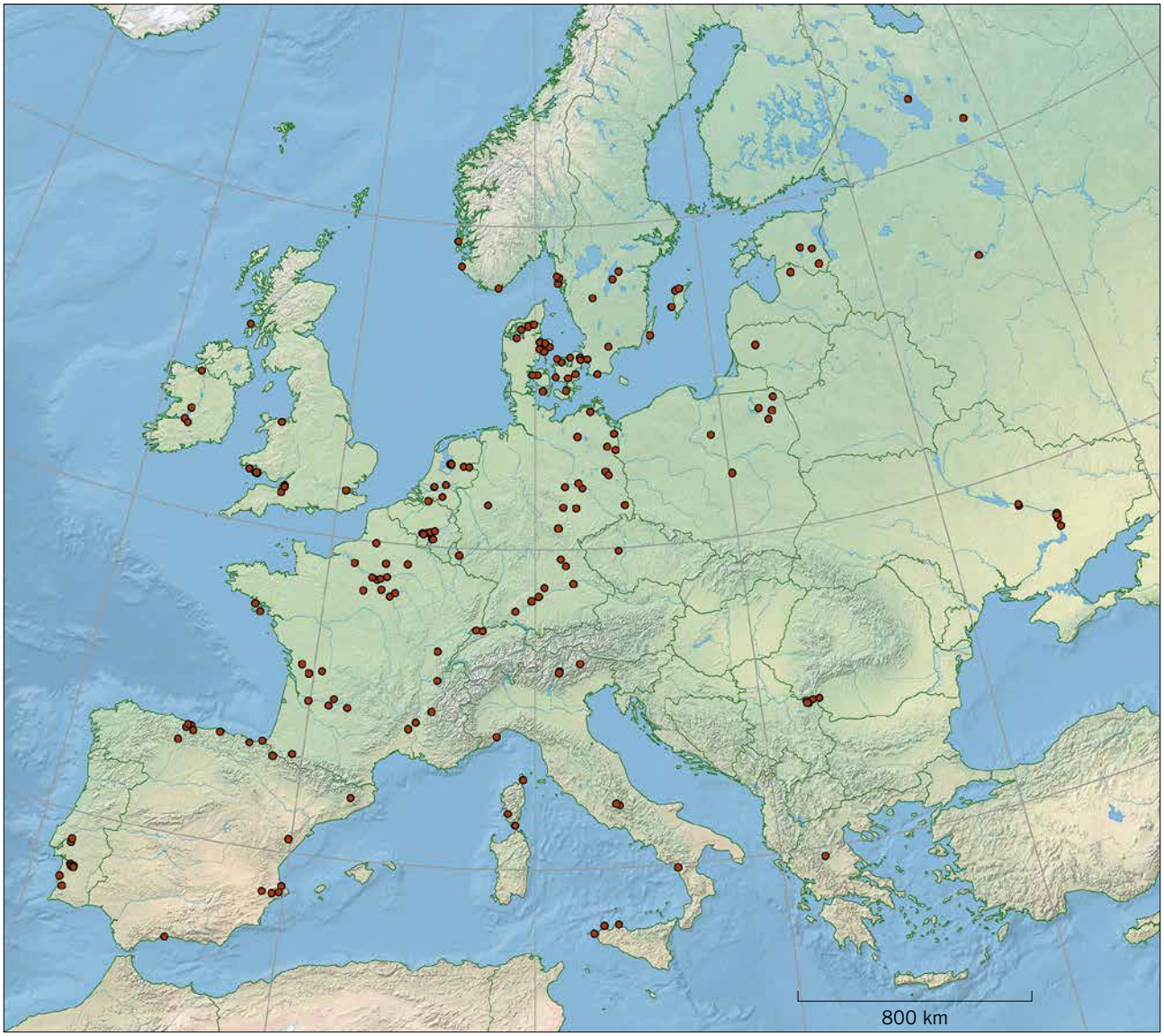

Fig. 1 Map of modern Europe showing Mesolithic European burial sites with direct or indirect radiocarbon dates.

cemeteries of 6250 BP and the suggestion of a threshold at ~6500 BP. Clark (2004) later repeated the latter figure[2].

The 1995 paper questioned the chronological assumptions with examples but no analysis. This had to wait until Belfast where an analysis of burial chronology was presented with sites from Portugal to the Ukraine, and a conclusion that »cemeteries, however defined, occur throughout the Mesolithic« (Meiklejohn et al. 2009, 642). When »cemeteries« were plotted against sites with smaller burial numbers, using three cemetery definitions (≥ 3 individuals, ≥ 4 individuals, ≥ 10 individuals), the average age of cemeteries was older in all three cases though not significantly so (ibid., Fig. 96,1). When age of sites was plotted by number of burials using seven age ranges the largest number (> 100 individuals) had a mean age that was one of the three oldest (ibid., Fig. 96,3). Single burials were one of the two youngest.

The Belfast results, while highly suggestive, may have been skewed by larger burial sites in north-eastern (Baltic States and Karelia) and eastern Europe (Ukraine). Our Brussels paper involved a more geographically restricted area with north-eastern and eastern sites removed. One Eastern European country was included, Poland, and a southern boundary used of the Loire Valley in France and the southern boundary of Germany. Results were similar; »cemetery sites are not a phenomenon restricted to the later Mesolithic« (Meiklejohn/Babb 2009, 227). In addition there was no obvious correlation between burial number and duration of site use, though a restricted dataset was used for this initially counterintuitive conclusion. We now turn to analysis of the substantially larger current dataset.

2 Clark/Neeley (1987) was widely cited and taken as authoritative. The 2004 volume was from a 1994 conference and though papers were updated elements appear not to have been altered, as in the reference to 6500 BP, as noted by Meiklejohn et al. (2009, 640). By 1995 four key sites cited by Clark (2004) were known to significantly predate 6500 BP, some by more than two millennia. The default date therefore remained in the literature far longer than it should have.

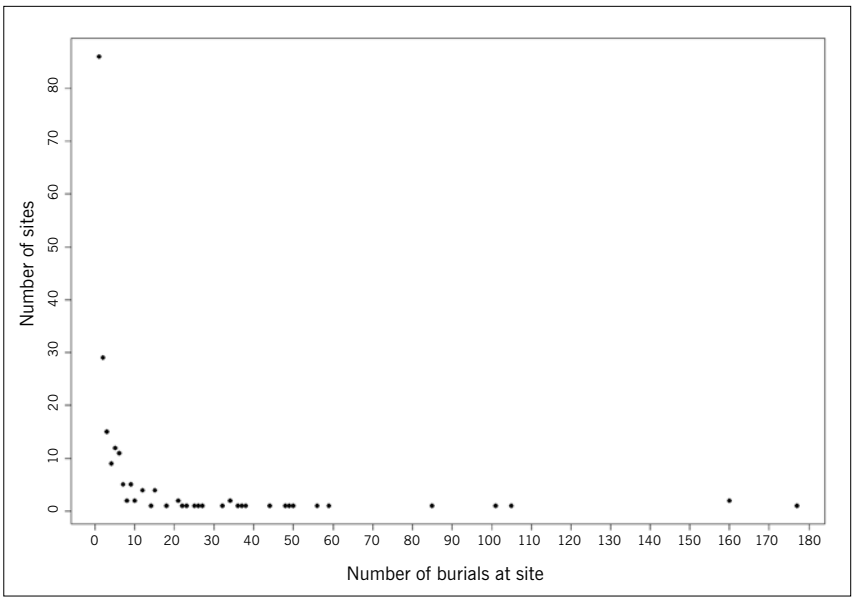

Fig. 2 Scatterplot of number of sites versus number of individuals buried at a site.

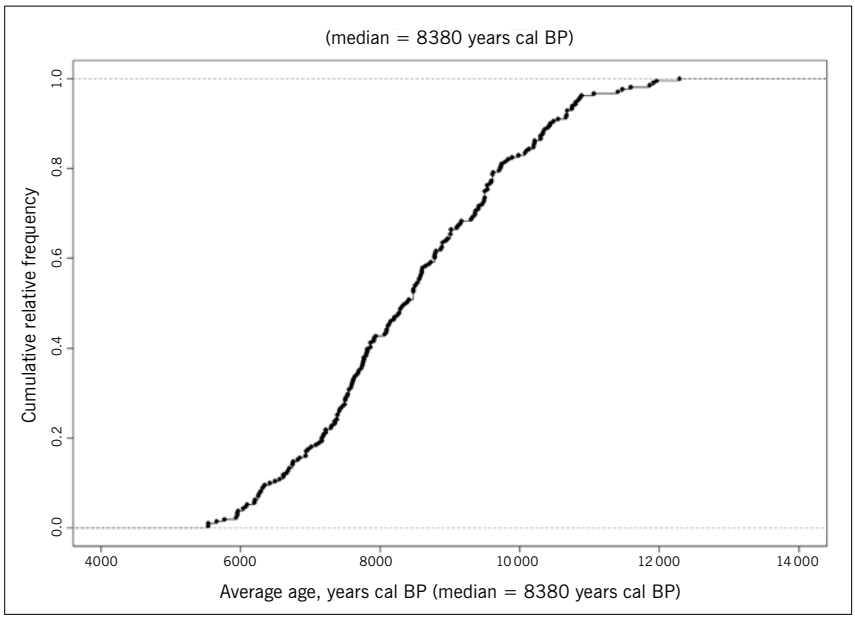

Fig. 3 Empirical cumulative distribution function of average age.

Analysis

From the above base the current analysis is of Mesolithic European burial sites with direct or indirect radiocarbon dates. Loose human bone (LHB) material is excluded. Included are 211 sites from 24 countries. Figure 1 depicts their locations.[3] The number of individuals per site ranged from one to 177, with a median of two. Figure 2 is a scatterplot of number of sites versus number of individuals buried at a site. After much consideration, we grouped the sites into six size categories, based on number of individuals buried at the site: 1 (individual burial), 2–3, 4–9, 10–15, 16–40, and > 40 individuals. Other possibilities were investigated, but led to similar findings. As suggested by Rick Schulting (pers. comm.), analysis of site duration excluded sites with only a single burial.

The average site age ranged from 5530 to 12 285 years cal BP with a median average of 8380 cal BP. Figure 3 depicts the empirical cumulative distribution function (ecdf) of the average ages. The curve is fairly continuous and sigmoidal, and can be used to visually identify sample percentiles of the average age dataset.

Figure 4 shows six parallel boxplots of average age versus cemetery size category. There is substantial overlap of average age distribution for the various groups. Medians of average ages for the six categories were compared using a nonparametric Kruskal-Wallis test; no statistically significant differences were detected (KW-statistic = 7.5988 with five degrees of freedom, p = 0.1798). For discussion of the Kruskal-Wallis test see for example, Daniel (1990) and Higgins (2004). The correlation coefficient between average age and burial number at a site is very low (r = 0.035).

3 Map base courtesy of Natural Earth.

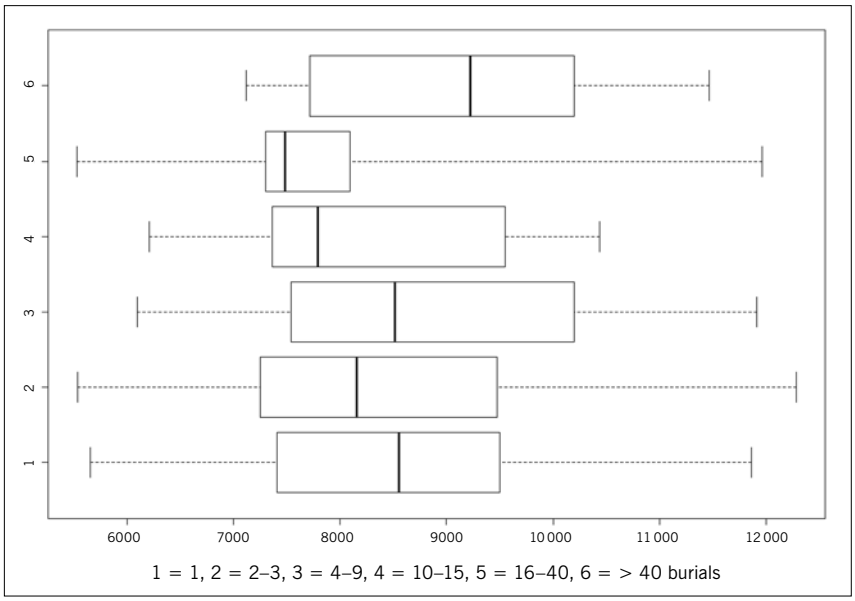

Fig. 4 Boxplots of average age of burial sites by cemetery size category.

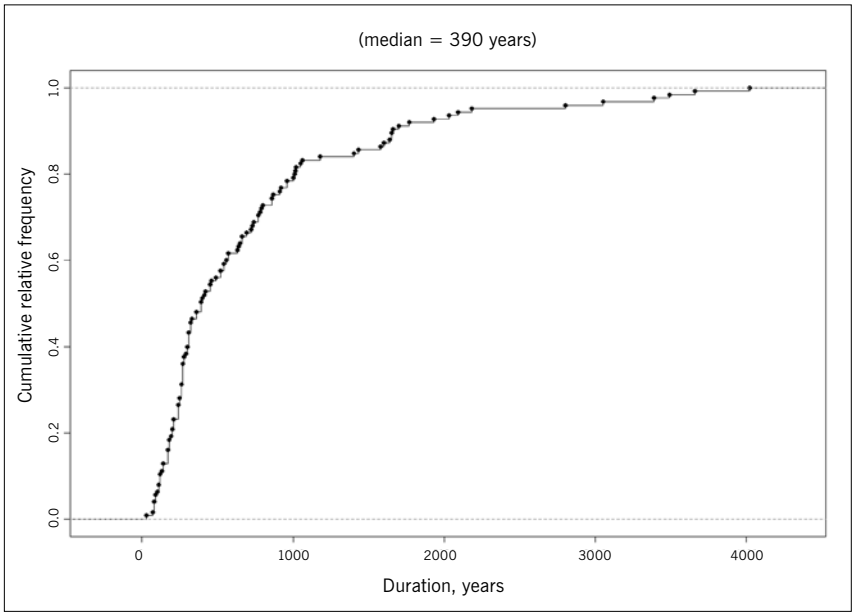

Fig. 5 Empirical cumulative distribution function of duration.

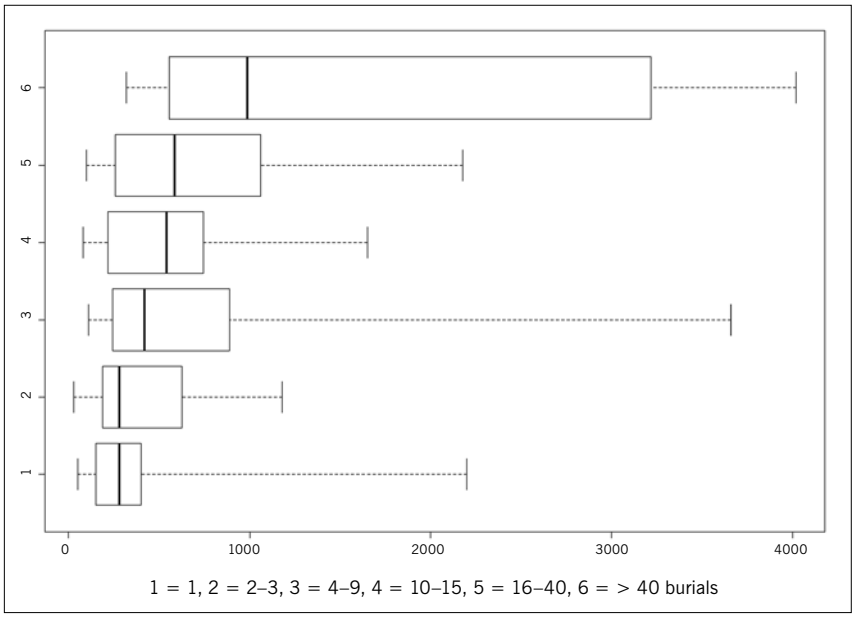

Fig. 6 Boxplots of duration of burial sites by cemetery size category.

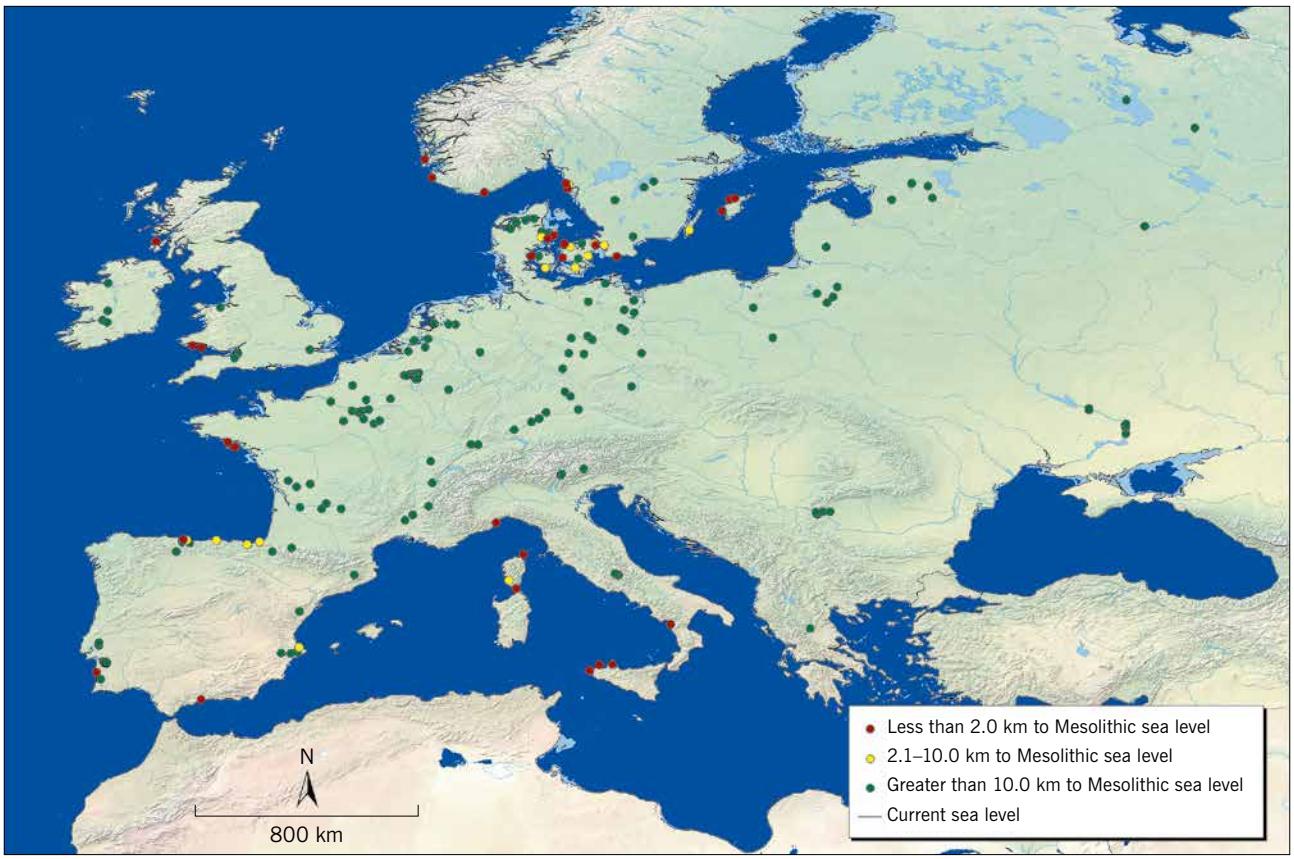

Fig. 7 Map of Mesolithic European burial sites showing modern Europe with coastline extended to 10 m below current sea level.

The durations of the burial sites ranged from 30 to 4020 years with a median of 390 years. Figure 5 depicts the ecdf of the durations. Figure 6 shows five parallel boxplots of duration versus cemetery size category (excluding sites with a single burial). Contrary to our earlier finding there appears to be a trend for duration to increase with cemetery size. A Kruskal-Wallis test was conducted to compare median durations for burials sites in the five size categories; there were statistically significant differences between medians (KW-statistic = 16.4582 with 54 degrees of freedom, p-value = 0.0025). The correlation coefficient between duration and number of burials at a site (excluding single burials) is moderately strong (r = 0.536).

Turning to geographic matters, we previously raised the issues of coastal proximity and marine diet (Meiklejohn/Babb 2009). At that time we divided the sites into three categories, coastal, near coastal (within 50 km of the coast), and non-coastal. At issue were two factors, that $\delta^{13}C$ values were only available for a limited number of sites and individuals, and the means of judging distance to the coast given complexity of sea level rise in the Early and Mid-Holocene. Issues of $\delta^{13}C$ value availability still exist and we have decided to again use coastal distance as a proxy variable for assessing site distribution, though with a difference. Availability of new bathymetric software (British Oceanographic Data Centre 2013) has greatly increased the accuracy of determining distance to the coast during the Holocene sea level rise.

We have calculated distance to nearest coastline for the 211 burial sites for three different sea levels: current sea level (csl), 10 m below csl, and 25 m below csl. Given space and time limitations we have based our analysis of coastal distance on a single value, 10 m below csl. We believe this approximates sea level at ~8300 cal BP, close to the median of the average ages of the sites. Figure 7 is a map of Mesolithic European burial sites showing modern Europe with coastline extended to 10 m below csl.[4] Coastal distances of the burial sites at 10 m below csl ranged from 0 to 527 km. The ecdf of the values (see Fig. 8) is fairly continuous and logarithmic in shape. Figure 9 is a scatterplot of average age versus coastal distance with the least squares line superimposed. There is a tendency (r = 0.19) for average age to increase with coastal distance.

Figure 10 depicts site duration with more than one burial versus coastal distance. With the exception of three high-leverage outliers in the top right corner of the plot, there is a tendency for duration to decrease with increasing coastal distance, contrary to the smaller dataset in Meiklejohn/Babb (2009). The three outlying points, with three of the four highest duration values and coastal distances between 355 and 368 km, are Olenii Ostrov, on Lake Onega in Russian Karelia, and the Danube Gorge sites of Vlasac and Padina in Serbia. It is striking that these outliers are each on a major lake or river.

Figure 11 depicts number of burials per site versus coastal distance. Six sites have high burial numbers. Three of these

4 Map base courtesy of Natural Earth.

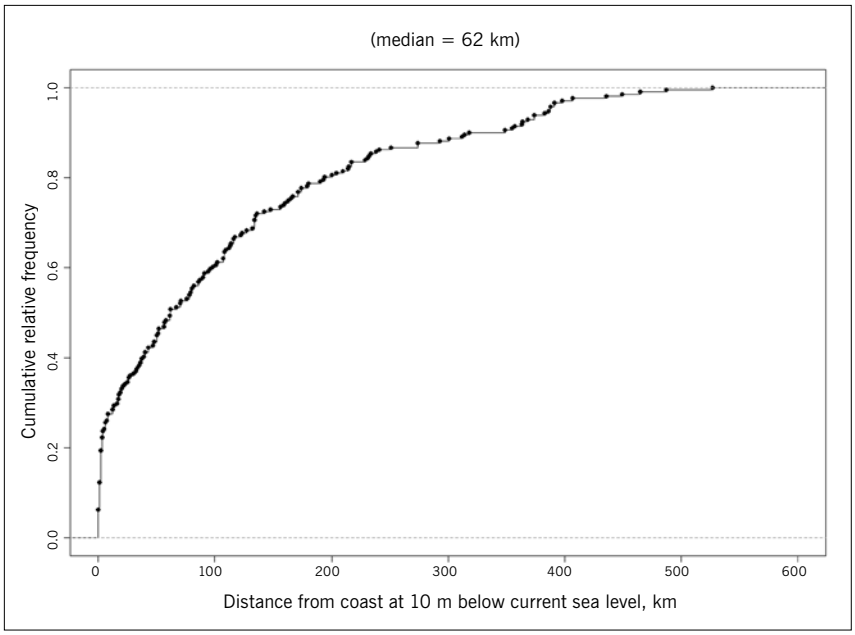

Fig. 8 Empirical cumulative distribution function of distance from coast at 10 m below current sea level.

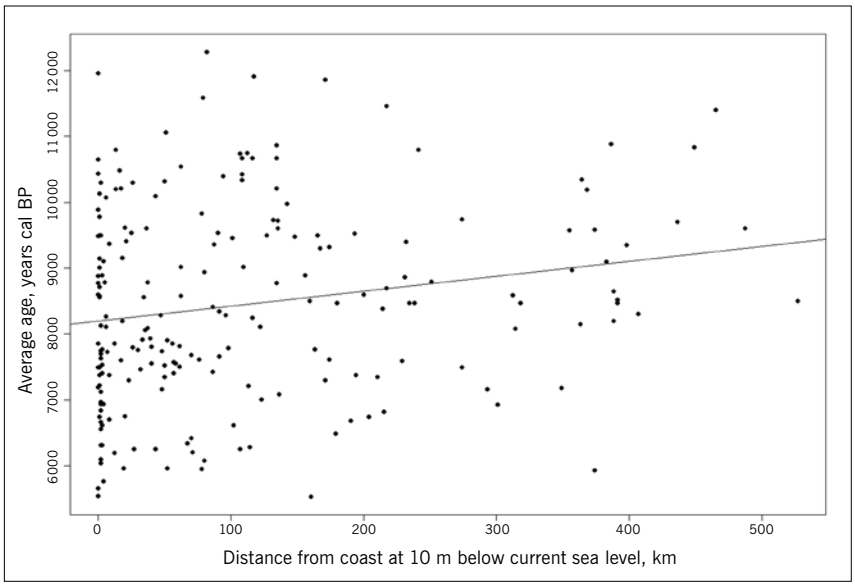

Fig. 9 Average age versus distance from coast at 10 m below current sea level, with least squares line superimposed.

(Cabeço da Arruda and Moita do Sebastião in Muge, Portugal and Zvejnieki in Latvia) are in the coastal distance range 56 to 58 km, and the remaining three (Olenii Ostrov in Russia, Lepenski Vir and Vlasac in Serbia) have coastal distances ranging from 355 to 364 km. In the case of the two Portuguese sites the coastal distances may be misleading since they were in estuarine conditions when occupied (Jackes/Meiklejohn 2008). The Serbian sites were both on the Danube with major freshwater fish resources. Both large lakes and major rivers add freshwater fish to issues involving site duration and burial number; we hope to consider these in more detail in a future study. Mean longitude and latitude values for all 211 sites were 8.14 degrees east and 49.76 degrees north, placing the geocentroid in central Germany. For each site, the great circle distance (gcd) from the geocentroid was calculated with the software package ›geosphere‹ using the Meeus method on the WGS84 ellipsoid (Hijmans et al. 2013). A least squares fit to a multiple linear regression model, with number of burials at site as the response variable and with regressor variables coastal distance and gcd from the geocentroid, yielded a coefficient of multiple determination $R^2 = 0.18$.

We grouped the 211 sites into three coastal distance categories: coastal (0 to ≤ 2 km); near-coastal (> 2 to ≤ 10 km) and inland (> 10 km). On the advice of Rick Schulting, we used the 10 km upper limit for the near-coastal category (rather than the 50 km upper limit of Meiklejohn/Babb 2009). Figure 12 shows three parallel boxplots of average age versus coastal distance. The median of average ages for inland sites seems to be greater than for both coastal and near-coastal sites. A nonparametric Kruskal-Wallis test was conducted to compare medians of the average ages for the three coastal distances categories and supported these findings (KW-statistic = 6.1846 with two degrees of freedom, p-value = 0.0454). Similar results, not presented here, were obtained using current sea level to determine coastal distance.

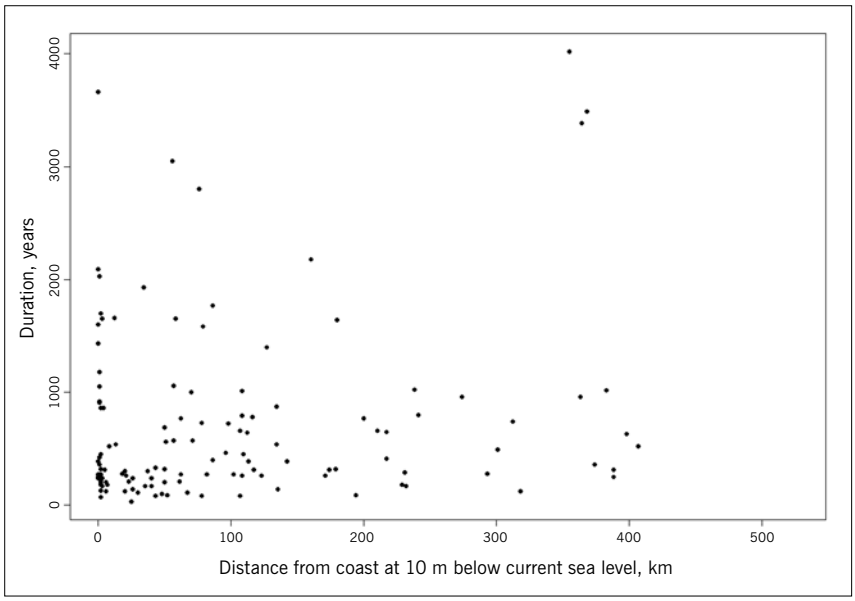

Fig. 10 Duration versus distance from coast at 10 m below current sea level, years.

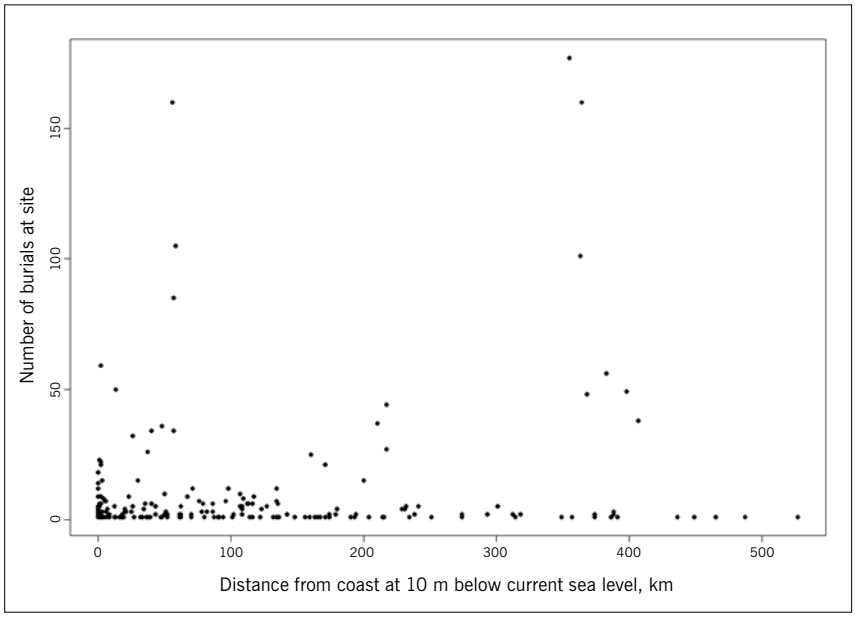

Fig. 11 Number of individuals buried at a site versus coastal distance at 10 m below current sea level.

Conclusion

This paper revisited issues of burial chronology raised in two previous studies (Meiklejohn et al. 2009; Meiklejohn/Babb 2009). Both had argued strongly that the idea that cemeteries, however defined, were a Late Mesolithic phenomenon was incorrect. If anything sites with larger burial numbers were earlier. This paper began by looking at the same question but with a site number that was almost twice the size of those used earlier. Similar results were found. In fact, the correlation coefficient between average age and burial number across the sample is very low (r = 0.035). This indicates that sites with multiple burials should be seen not as a developing phenomenon within the Mesolithic but as a feature found throughout the Mesolithic. Roots of this within the Upper Palaeolithic need further exploration.

We looked at a broader set of burial number categories than used in the earlier papers, five as compared to three. Using the Kruskal-Wallis test we found no significant difference in the median ages of the five categories and considerable overlap in their distribution, as might be expected. Turning to duration of use of a site for burial as measured by direct ^{14}C dates from the burials, we found that there was a positive correlation coefficient between site duration and burial number (r = 0.536), refuting the surprising lack of correlation found in our earlier papers. We would note that sites with single burials were included in the earlier analysis of this relationship but excluded here.

Turning to geographic aspects of the data we should note that initial examination of the material found no major correlation of aspects such as site location or burial number with basic geographical coordinates. We then revisited the issue of relationship of burial number and site chronology with coastal proximity. Our earlier analysis was centred on isotope values and marine diet, and our broad results were suspect given the limited availability of stable isotope val-

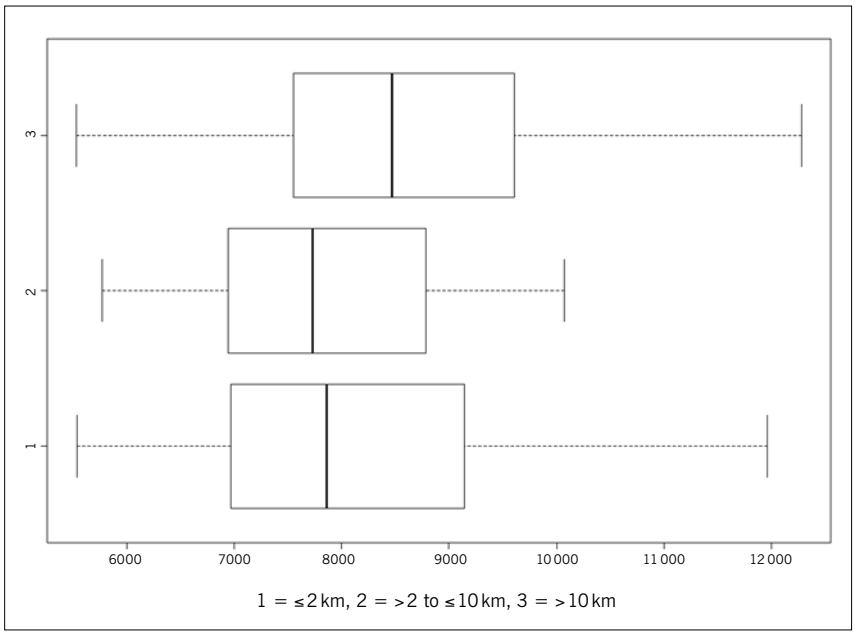

Fig. 12 Boxplots of average age by coastal distance category at 10 m below current sea level.

ues, especially in non-coastal sites. A further problem was that we used distance to current coastal location. In this paper we adjusted our distance categories and used newly available software to calculate site distance to an average Early-Mid Holocene sea level of 10 m below csl. We found a tendency for average age to increase with coastal distance (r = 0.19). Full interpretation of this is premature as one aspect may be simply that sea level rise has led to the loss of early coastal sites. We did, however, find that outlier sites in the analysis tended to be found on either large lakes or major rivers, a variable that we did not adjust for here. In addition, space and time limitations prevented our attempting to look at individual sea level depression values for sites of different ages, rather than the single value used here. Finally, multiple linear regression showed a joint link between burial number and distance from the coast ($R^2 = 0.18$).

In summation, our expanded analysis shows most clearly that there is no overall trend towards sites with multiple burials, cemeteries if you wish, over the course of the Mesolithic. Burial number and age are largely uncorrelated. We have also shown that our earlier conclusion showing a lack of correlation between number of burials and duration of site is incorrect, as logic might suggest. The expanded data set that we have used here removes earlier queries about issues of sampling. Though initial exploration of geographical variation shows very little overall patterning, there is apparent linkage between age of sites, duration of occupation and coastal location, corroborating earlier work from a number of perspectives. Similar linkage for sites on large lakes and major rivers needs further exploration. What does seem evident is that an overall uniformity of pattern across European Mesolithic burial patterns is balanced against multiple local variations or perturbations, as seen in differences between neighbouring countries or between regions within individual countries.

Acknowledgements

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Source of figures

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Appendix

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Belgium	Abri des Autours	50.22	4.89	1992					Yes	Yes
Belgium	Bois Laiterie	50.36	4.87	1990					Yes	Yes
Belgium	Chaleux	50.22	4.94	1865	X	Yes (Upal)	X	X	X	Yes
Belgium	Claminforge	50.41	4.62	1988					Yes	Yes
Belgium	Faille du Burin	50.47	5.00	1989					X	Yes
Belgium	Grotte Margaux	50.22	4.89	1988					Yes	Yes
Belgium	Lombeau	50.38	4.39	post-1990					Yes	Yes
Belgium	Loverval	50.36	4.46	1983					Yes	Yes
Belgium	Magrite	50.22	4.91	1864	X	Yes (Upal)	X	X	X	Yes
Belgium	Malonne (Petit-Ri)	50.43	4.80	1962		X	Yes	X	Yes	Yes
Czech Republic	Bacin Hill	49.90	14.10	before 2000					X	Yes
Denmark	Argus-Grund	54.91	11.70	1984					Yes	Yes
Denmark	Dragsholm	55.79	11.48	1973			X	X	Yes	Yes
Denmark	Dyrholmen	56.43	10.27	1939	Yes	Yes	Yes	X	X	Yes
Denmark	Ertebølle	56.81	9.18	1895	X	X	X	X	Yes	Yes
Denmark	Gøngehusvej 7	55.85	12.56	1987					X	Yes
Denmark	Hedegård	56.91	9.58	before 2007					X	Yes
Denmark	Henriksholm-Bøgebakken	55.85	12.56	1975				Yes	Yes	Yes
Denmark	Holmegård V	55.29	11.83	before 1950	X	X	X	X	Yes	Yes
Denmark	Holmegård-Jutland	56.27	10.80	1967		X	X	Yes	Yes	Yes
Denmark	Koed	56.38	10.57	before 1960	X	X	X	X	Yes	Yes
Denmark	Koelbjerg	55.40	10.13	1941	Yes	Yes	Yes	Yes	X	Yes
Denmark	Korsør Glasværk	55.33	11.15	1944	X	X	X	X	X	Yes
Denmark	Korsør Nor	55.33	11.15	1943	Yes	Yes	Yes	Yes	Yes	Yes
Denmark	Melby	55.93	11.98	1969		X	Yes	Yes	Yes	Yes
Denmark	Møllegabet II	54.90	10.42	1976				X	Yes	Yes
Denmark	Nivå 10	55.92	12.52	1995					Yes	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Denmark	Nivågård	55.92	12.52	1912	X	X	X	X	Yes	Yes
Denmark	Norsminde	56.20	10.25	1973			X	X	Yes	Yes
Denmark	Rønbjerg	56.54	8.93	before 1998					X	Yes
Denmark	Sejrø	55.90	11.23	1956		X	Yes	X	Yes	Yes
Denmark	Strøby Egede	55.41	12.24	1985					X	Yes
Denmark	Tingbjerggård Vest	56.97	9.93	before 2007					X	Yes
Denmark	Tybrind Vig	55.40	9.83	1976				Yes	Yes	Yes
Denmark	Vænge Sø	56.13	10.52	1975				X	Yes	Yes
Denmark	Vænge Sø Vest	56.13	10.52	before 2000					Yes	Yes
Denmark	Vedbæk-Boldbaner	55.85	12.56	1944	Yes	Yes	Yes	Yes	Yes	Yes
Estonia	Kivisaare	58.45	26.09	1882	X	X	Out of area	Out of area	X	Yes
Estonia	Tamula	57.84	26.98	1942	X	X	Out of area	Out of area	X	Yes
Estonia	Veibri	58.34	26.78	2003					X	Yes
France	Araguina-Sennola (Bonifacio)	41.39	9.16	1972			X	Yes	X	Yes
France	Auneau	48.45	1.79	1986					Yes	Yes
France	Aven des Iboussières	44.49	4.75	1994					X	Yes
France	Baume de Montclus	44.27	4.42	1954	X	Yes	Yes	Yes	X	Yes
France	Bourg-Charente	45.67	–0.22	2010						Yes
France	Campu Stefanu	41.74	8.86	2011						Yes
France	Combe Capelle	44.75	0.85	1909/2011						Yes
France	Concevreux	49.38	3.79	2006					X	Yes
France	Culoz (Sous Balme)	45.84	5.58	1957		Yes	Yes	Yes	Yes	Yes
France	Cuzoul de Gramat	44.75	1.68	1928	Yes	Yes	Yes	Yes	X	Yes
France	Hoëdic	47.35	–2.86	1933	Yes	Yes	Yes	Yes	Yes	Yes
France	Houleau 2	44.82	–0.08	before 1997					X	Yes
France	La Madeleine	44.98	1.04	1926	X	X	X	X	X	Yes
France	La Vergne (La Grande Pièce)	45.93	–0.57	1995					Yes	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
France	Le Petit Marais (La Chaussée-Tirancourt)	49.95	2.17	1990					Yes	Yes
France	Les Perrats (Agris)	45.80	0.36	1992					X	Yes
France	Maisons-Alfort (Zac d'Alfort)	48.82	2.41	1998					X	Yes
France	Mannlefelsen I (Oberlarg)	47.46	7.24	1976				Yes	X	Yes
France	Mareuil-lès-Meaux (Les Vignolles)	48.93	2.86	2001					X	Yes
France	Melun (Quai Voltaire)	48.53	2.64	1991					X	Yes
France	Monte Leone	41.39	9.18	before 2007					X	Yes
France	Neuilly-sur-Marne (La Haute-Île)	48.86	2.56	1999					X	Yes
France	Noyen-sur-Seine	48.46	3.33	1984					X	Yes
France	Poeymaü (Arudy)	43.10	–0.44	1949	Yes	Yes	Yes	Yes	X	Yes
France	Rueil-Malmaison (Le Closeau)	48.87	2.15	1995					X	Yes
France	Ruffey-sur-Seille (À Daupharde)	46.75	5.51	1996					X	Yes
France	St.-Agnan-en-Vercors (Grotte Joëlle)	44.86	5.42	1983					Yes	Yes
France	Téviec	47.56	–3.16	1928	Yes	Yes	Yes	Yes	Yes	Yes
France	Torre d'Aquila 2 (Pietracorbara)	42.83	9.48	1986					X	Yes
France	Val-de-Reuil (Les Varennes)	49.26	1.24	1991					Yes	Yes
France	Verberie (Le Buisson Campin)	49.34	2.75	1977				X	X	Yes
France	Villeneuve-la-Guyard (Falaises de Prépoux)	48.34	3.08	1985					Yes	Yes
Germany	Bad Dürrenberg	51.27	12.07	1934	X	X	X	Yes	Yes	Yes
Germany	Berlin-Schmöckwitz (Försteracker)	52.37	13.65	1925	Yes	X	Yes	X	Yes	Yes
Germany	Blätterhöhle (Hagen)	51.35	7.62	2004					X	Yes
Germany	Bocksteinhöhle	48.55	10.15	1883/2000					X	Yes
Germany	Bottendorf	51.30	11.42	1939	Yes	Yes	Yes	X	Yes	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Germany	Büttnerloch	49.69	11.25	1929/2006					Yes	Yes
Germany	Coswig	51.88	12.43	2001					X	Yes
Germany	Criewen	53.02	14.22	1961/62					Yes	Yes
Germany	Falkensteinhöhle	48.08	9.08	1933	Yes	Yes	Yes	X	X	Yes
Germany	Fuchskirche I (Allendorf)	50.65	11.16	1960		X	X	X	X	Yes
Germany	Groß Fredenwalde	53.13	13.80	1962, 2012/13					Yes	Yes
Germany	Grosse Ofnet	48.82	10.45	1908	Yes	Yes	Yes (Upal)	X	Yes	Yes
Germany	Hohlenstein-Stadel	48.55	10.17	1937	Yes	Yes	Yes	X	Yes	Yes
Germany	Hohler/Hohle Fels (Happurg)	49.48	11.49	1906	X	X	X	X	X	Yes
Germany	Höhlesbuckel (Blaubeuren-Altental)	48.41	9.83	1949	X	X	X	X	Yes	Yes
Germany	Kolberg	52.25	13.82	1955		X	X	X	Yes	Yes
Germany	Plau	53.47	12.25	1846	X	X	X	X	Yes	Yes
Germany	Rothenklempenow	53.52	14.20	1988					X	Yes
Germany	Schöpsdorf	51.30	14.54	1983					X	Yes
Germany	Steinhagen	54.23	12.99	1986					Yes	Yes
Germany	Unseburg	51.93	11.52	1984					Yes	Yes
Germany	Urdhöhle	52.03	12.23	1952/53	X	X	X	X	X	Yes
Great Britain	Aveline's Hole	51.33	–2.75	1797	Yes (Upal)	Yes (Upal)	Yes (Upal)	Yes	Yes	Yes
Great Britain	Cnoc Coig	56.02	–6.24	1973			X	Yes	X	Yes
Great Britain	Daylight Rock	51.64	–4.67	1951	X	X	X	X	X	Yes
Great Britain	Foxhole Cave	51.55	–4.25	1997					X	Yes
Great Britain	Gough's (New) Cave (Cheddar)	51.28	–2.76	1903	X	Yes (Upal)	Yes (Upal)	Yes	Yes	Yes
Great Britain	Greylake	51.10	–2.88	1928/2011						Yes
Great Britain	Mewslade Bay	51.56	–4.28	before 1923?	X	X	X	X	X	Yes
Great Britain	Ogof-yr-Ychen	51.64	–4.68	1970		X	X	X	Yes	Yes
Great Britain	Pontnewydd Cave	53.23	–3.48	1980					X	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Great Britain	Potter's Cave	51.64	–4.68	1950	X	X	X	X	X	Yes
Great Britain	Tilbury 1	51.45	0.35	1883/2011						Yes
Great Britain	Totty Pot	51.28	–2.74	1960		X	X	X	Yes	Yes
Great Britain	Worm's Head	51.56	–4.33	1966		X	X	X	X	Yes
Greece	Theopetra	39.71	21.75	1993					Yes	Yes
Ireland	Hermitage	52.70	–8.52	2001					X	Yes
Ireland	Killuragh Cave	52.60	–8.32	1993					X	Yes
Ireland	Sramore	54.26	–8.28	before 2006					X	Yes
Ireland	Stoney Island	53.08	–8.3	1929	X	X	X	X	X	Yes
Italy	Arene Candide	44.16	8.32	1940	Yes	Yes (Upal)	X	X	Yes	Yes
Italy	Grotta Continenza	41.96	13.54	1993					X	Yes
Italy	Grotta d'Oriente	37.94	12.31	1972			X	X	X	Yes
Italy	Grotta dell'Uzzo	38.18	12.72	1975				X	Yes	Yes
Italy	Grotta della Madonna	39.89	15.78	1966		X	X	Yes	X	Yes
Italy	Maritza	42.02	13.41	1961		Yes (Upal)	X	X	X	Yes
Italy	Mezzocorona	46.22	11.11	1995					Yes	Yes
Italy	Molara	38.20	13.29	1968		X	X	X	Yes	Yes
Italy	Mondeval de Sora	46.44	12.06	1987					Yes	Yes
Italy	Vatte di Zambana	46.17	11.08	1967		Yes	X	Yes	X	Yes
Latvia	Zvejnieki	57.77	25.23	1960		X	Out of area	Out of area	Yes	Yes
Lithuania	Donkalnis	55.81	22.44	1982					Yes	Yes
Lithuania	Spiginas	55.77	22.44	1990					Yes	Yes
Luxembourg	Loschbour	49.76	6.28	1935	Yes	Yes	Yes	Yes	Yes	Yes
Netherlands	Dalfsen	52.52	6.28	1973			X	Yes	Yes	Yes
Netherlands	Hardinxveld-Giessendam/ De Bruin	51.83	4.81	1997					Yes	Yes
Netherlands	Hardinxveld-Giessendam/ Polderweg	51.84	4.82	1997					Yes	Yes
Netherlands	Mariënberg	52.51	6.57	1975				X	X	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Netherlands	Oirschot 5-21	51.55	5.27	1957		X	X	X	Yes	Yes
Netherlands	Rotterdam	51.38	4.56	2008					X	Yes
Netherlands	Swifterbant N23/N307	52.55	5.63	2010						Yes
Netherlands	Swifterbant S11	52.59	5.63	1974			X	X	X	Yes
Netherlands	Swifterbant S2	52.58	5.58	1967		X	X	X	Yes	Yes
Netherlands	Swifterbant S21/22/23	52.58	5.64	1973			X	X	X	Yes
Netherlands	Zoelen	51.91	5.40	1991					Yes	Yes
Norway	Bleivik	59.47	5.25	1952	X	Yes	X	Yes	X (LHB)	Yes
Norway	Søgne	58.08	7.81	1994					X	Yes
Norway	Viste (Svarthålå)	58.70	5.57	1909	X	X	X	X	Yes	Yes
Poland	Dręstwo 10	53.43	22.46	1995					X	Yes
Poland	Janisławice	51.96	20.15	1936	X	X	Out of area	Out of area	Yes	Yes
Poland	Kamieńskie 1	53.82	22.04	before 2003					X	Yes
Poland	Mszano	53.22	19.32	1987					X	Yes
Poland	Pierkunowo	54.10	22.91	1965		X	Out of area	Out of area	Yes	Yes
Poland	Woźna Wieś	53.68	22.73	before 1990					Yes	Yes
Portugal	Arapouco (Sado)	38.32	–8.49	1955		X	X	X	Yes	Yes
Portugal	Cabeço da Amoreira (Muge)	39.10	–8.67	1892	Yes	Yes	Yes	Yes	Yes	Yes
Portugal	Cabeço da Arruda (Muge)	39.11	–8.67	1865	Yes	Yes	Yes	Yes	Yes	Yes
Portugal	Cabeço das Amoreiras (Sado)	38.26	–8.38	1955		X	X	X	Yes	Yes
Portugal	Cabeço do Pez (Sado)	38.28	–8.33	1955		X	X	X	Yes	Yes
Portugal	Cova da Onça (Magos)	38.99	–8.68	1880	X	X	X	X	Yes	Yes
Portugal	Fiais (Mira)	37.57	–8.61	1986					X	Yes
Portugal	Moita do Sebastião (Muge)	39.11	–8.68	1863	Yes	Yes	Yes	Yes	Yes	Yes
Portugal	Poças de São Bento (Sado)	38.26	–8.44	1955		X	X	X	X	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Portugal	Samouqueira I	37.87	–8.79	1984					Yes	Yes
Portugal	Vale de Romeiras (Sado)	38.24	–8.36	1955		X	X	X	X	Yes
Portugal	Várzea da Mó (Sado)	38.25	–8.34	1955		X	X	X	X	Yes
Romania	Schela Cladovei	44.63	22.60	1991					Yes	Yes
Russia	Olenii Ostrov	61.96	35.27	1936	X	X	Out of area	Out of area	Yes	Yes
Russia	Ozerki 17	56.65	36.06	before 1998					X	Yes
Russia	Peschanista	60.79	38.20	1986					Yes	Yes
Serbia	Hajdučka Vodenica	44.63	22.29	1966		X	Out of area	Out of area	Yes	Yes
Serbia	Lepenski Vir	44.52	22.06	1965		X	Out of area	Out of area	Yes	Yes
Serbia	Padina	44.61	22.00	1968		X	Out of area	Out of area	Yes	Yes
Serbia	Vlasac	44.55	22.03	1970		X	Out of area	Out of area	Yes	Yes
Spain	Aizpea	42.95	–1.26	1988					Yes	Yes
Spain	Cingle del Mas Nou	40.43	–0.11	1986					Yes	Yes
Spain	Colomba	43.44	–4.92	1915	X	X	X	X	Yes	Yes
Spain	Cueva de Braña-Arintero	42.95	–5.37	2006					X	Yes
Spain	Cueva del Higuerón	36.72	–4.3	2005?					X	Yes
Spain	El Cingle Vermell	41.96	2.24	1978				X	X	Yes
Spain	El Collado	38.92	–0.12	1987					Yes	Yes
Spain	El Truchiro (La Garma)	43.42	–3.66	2002/06					Yes	Yes
Spain	Jaizkibel (J3)	43.36	–1.81	2003					Yes	Yes
Spain	La Corona	38.68	–0.88	2008					X	Yes
Spain	Linatzeta	43.25	–2.33	2004					X	Yes
Spain	Los Azules	43.36	–5.13	1973			X	X	X	Yes
Spain	Los Canes	43.32	–4.8	1985					Yes	Yes
Spain	Penya del Comptador	38.66	–0.47	2005?					X	Yes
Spain	Santa Maira	38.72	–0.2	1980s					X	Yes
Spain	Tito Bustillo	43.46	–5.07	1968		X	X	X	X	Yes

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Sweden	Alby	56.48	16.58	1968/1993					X	Yes
Sweden	Alvastra	58.30	14.64	1980/2009					X	Yes
Sweden	Bäckaskog (Barum)	56.22	14.17	1939	X	Yes	Yes	Yes	Yes	Yes
Sweden	Bredgården	57.75	13.40	1994					X	Yes
Sweden	Evensås	58.23	11.37	1930/2000					Yes	Yes
Sweden	Kams (Lummelunda)	57.78	18.30	1939	X	Yes	Yes	X	Yes	Yes
Sweden	Kanaljorden	58.53	15.05	2011						Yes
Sweden	Österöd	58.40	11.42	1933/2009					X	Yes
Sweden	Skateholm 1	55.38	13.48	1980					Yes	Yes
Sweden	Skateholm 2	55.38	13.48	1982					X	Yes
Sweden	Skateholm 3	55.38	13.47	1930/1985					Yes	Yes
Sweden	Stångenäs	58.41	11.43	1842	Yes	Yes	Yes	Yes	X	Yes
Sweden	Stora Bjers (Stora Bjärs)	57.83	18.53	1953	X	Yes	Yes	Yes	Yes	Yes
Sweden	Stora Förvar	57.29	17.98	1991					Yes	Yes
Sweden	Tågerup	55.86	12.94	1998					Yes	Yes
Sweden	Uleberg	58.45	11.30	1929	X	X	X	Yes	Yes	Yes
Switzerland	Birsmatten-Basisgrotte	47.45	7.55	1944	Yes	Yes	Yes	Yes	Yes	Yes
Ukraine	Derievka	48.92	33.67	1960					Yes	Yes
Ukraine	Marievka	48.18	35.25	before 1987					Yes	Yes
Ukraine	Osipovka	48.98	33.67	1970					Yes	Yes
Ukraine	Vasil'evka II	48.33	35.26	1953					Yes	Yes
Ukraine	Vasil'evka III	48.33	35.26	1957					Yes	Yes
Ukraine	Vasil'evka V	48.27	35.22	before 1987					Yes	Yes
Ukraine	Yasinovatka	47.92	35.25	1978					Yes	Yes
Denmark	Bergmansdal	56.05	12.63	1955		X	X	X	Yes	X (LHB)
Denmark	Køge Sønakke (Køge Bugt)	55.50	12.42	1980					Yes	X (LHB)
Germany	Bettenroder Berg IX	51.47	10.17	1988/89					Yes	X (post-Meso)

Country	Site	Lat.	Long.	Burials discovered	1953	1971	1974	1979	2009	2013
Netherlands	Schokland P14	52.65	5.78	1984					Yes	X (post-Meso)
Netherlands	Urk E4	52.65	5.62	1997					Yes	X (post-Meso)
Russia	Popovo	60.51	39.45	before 1984					Yes	X (date prob-lem)
Spain	Cueva de Nerja	36.78	–3.86	1982					Yes	X (not dated)
Denmark	Bloksbjerg	55.77	12.58	before 1927	X	X	X	Yes	X	X (not dated)
Denmark	Brovst	57.10	9.50	1964		X	X	Yes	X	X (not dated)
Denmark	Sværdborg I 1921	55.09	11.86	1921	Yes	X	Yes	Yes	X	X (not dated)
Denmark	Villingbæk Ost A	56.08	12.42	1966		X	X	Yes	X	X (not dated)
France	Abri Cornille	43.53	5.00	1946	X	X	X	Yes	X	X (UPal)
France	Rastel	43.79	7.40	1961		Yes	Yes	Yes	X	X (post-Meso)
France	Roc du Barbeau	44.99	1.04	1934	Yes	Yes	Yes	Yes	X	X (not dated)
France	Trou Violet (Montardit)	43.07	1.20	1924	Yes	Yes	Yes	Yes	X	X (not dated)
Germany	Felsställe (Mühlen)	48.28	9.50	1974			X	Yes	X	X (post-Meso)
Germany	Schellnecker Wänd (*)	48.93	11.83	1972			X	Yes	Yes	X (post-Meso)
Spain	Colombres (Molino de Gasparín)	43.37	–4.53	1926	X	X	X	Yes	X	X (not dated)
Sweden	Store Mosse	56.01	13.75	1954		X	X	Yes	X	X (not dated)

(*) The Schellnecker Wänd date was changed from Mesolithic to post-Mesolithic after the statistical analysis was performed. Therefore the new date is not reflected in the analysis.

Tab. 1 Burial sites as listed in various catalogues.